Established in 1871

Swiss Medical Weekly

Formerly: Schweizerische Medizinische Wochenschrift

An open access, online journal • www.smw.ch

Original article | Published 9 February 2016, doi:10.4414/smw.2016.14272

Cite this as: Swiss Med Wkly. 2016;146:w14272

Climate data, localisation of the sting, grade of anaphylaxis and therapy of hymenoptera stings

A five-year analysis from 2009–2013 in the University Emergency Department of the Insel Hospital Bern

Christian T. Braun[a*], *Mirko Mikula*[a*], *Meret Ricklin*[a], *Aristomenis K. Exadaktylos*[a], *Arthur Helbling*[b]

[a] University Emergency Department, Insel Hospital, University Hospital Bern, Switzerland

[b] University Clinic for Rheumatology, Immunology and Allergology, Insel Hospital, University Hospital Bern, Switzerland

* shared first-authorship, as both authors equally contributed to this work

Summary

International epidemiological studies indicate that around 1–7% of the population respond with an allergic reaction to a hymenoptera sting, which is frequently associated with admission to an emergency department. This retrospective study included patients admitted between 2009 and 2013 to an emergency department after a hymenoptera sting. In all, 86 (60.1%) men and 57 (39.9%) women were included in the study. The mean age was 43 years, with a range from 19 to 84 years. The most common localisations of a sting were the head (n = 33; 22.5%), the hands (n = 32; 21.9%) and the arms (n = 26; 17.8%). In women, we recorded significantly more stings in distal extremities (p = 0.033) and in men stings in the rump and head were most frequent. Local swellings were observed in 67.1% (n = 96) of patients and 34.3% (n = 49) patients exhibited an anaphylactic reaction. Of these, 21.7% (n = 31) suffered from a grade I, 6.3% (n = 9) grade II, 4.2% (n = 6) grade III and 2.1% (n = 3) grade IV anaphylactic reactions. 46% (66) of the patients were given antihistamines, 45% (64) intravenous glucocorticoids and only 12.5% (16) epinephrine. Most stings were recorded on days without rainfall (p = 0.013), with more hours of sunshine (p = 0.001), low relative humidity (p = 0.006), with mean air pressure above 954.3 hPa and on days with mean temperature above 24.2 °C (p = 0.001). In conclusion, the most hymenoptera stings induced local swelling only; severe reactions were rare. The most dangerous stings are enoral and result from inattentive drinking. Epinephrine was rarely used in anaphylactic reactions.

Key words: *Hymenoptera; anaphylactic reaction; adrenaline*

Introduction

There has recently been an upsurge of media reports on hymenoptera, including bees, wasps and ants. On the one hand, some articles have reported the mass death of bees from disease or habitat destruction; on the other hand, it is claimed that insects have become more aggressive towards humans [1]. International epidemiological studies indicate that about 1–7% of the population mount an allergic reaction to a hymenoptera sting. These stings are often the reason for admission to an emergency department (ED) [2]. Overall, 0.2–1% of all ED admissions are due to allergic reactions from any cause [3]. In 2004 in the canton of Bern, the annual incidence of anaphylactic reactions was 7.9–9.6 cases per 100 000 inhabitants. Of these, 58.8% were due to a hymenoptera sting [4]. In older people, anaphylactic reactions are overwhelmingly associated with drug allergies. Data from other European countries indicate that around half of the reported cases of anaphylactic reactions were due to wasp or bee stings [5]. Medication and food are the other main causes that may lead to a severe anaphylactic reaction [6, 7]. The risk of an allergic reaction after a hymenoptera sting not only depends on the number of stings and dose of the venom – approximately 20 µg per sting for wasps, and 50 µg per sting for bees [9] – but also on other factors, including the frequency of the stings, interval between stings, mast cell load and medication [8]. Independently of any anaphylactic reaction, humans can die of a lethal dose of the venom. The threshold for this is around 20 stings per kg bodyweight [9]. There are anecdotal, reports of individuals who survived several thousand stings. The clinical symptoms of an acute anaphylactic reaction frequently start with pruritus in the palmoplantar or hairy body regions, and then develop to generalised urticaria or are associated with gastrointestinal symptoms such as epigastric cramps, diarrhoea or dyspnoea. The symptoms may extend to cardiovascular complications with hypotension and shock [10].

The aim of the study was to describe in an exploratory way the frequency and grade of anaphylaxis, the therapy of the hymenoptera sting, and secondary climate data and the localisation of the stings of patients admitted to the ED of the Inselspital over the past 5 years.

Materials and methods

Approximately 38 000 adult patients per year are admitted to the Emergency Department (ED) of Bern University Hospital. The present retrospective study included all patients admitted as a result of a hymenoptera sting between 1 January 2009 and 31 December 2013. The electronic database with health-related data was searched with the key words "bee", "wasp" or "anaphylaxis". The clinic programs used were Qualicare (Qualidoc AG, Trimbach, Switzerland) and E.Care (E.care bvba, Turnhout, Belgium). The analysis included the date and time of the sting, age and sex of the patient, localisation of the sting and the provoked symptoms. Anaphylactic reactions were graded according to H.L. Mueller [11, 12]. In addition, local weather data were included (Messstation Zollikofen, Kanton Bern, MeteoSwiss) [13]. For comparison calculations, weather data from days with stings were compared with the mean values from June to September 2009 to 2013. Rainfall, humidity, pressure, temperature, and the number of hours of sun relative to daylight hours were included in the analysis. Mean data from May to October were compared from 2009 to 2013, in order to identify possible differences between the summers in each year. The Federal Statistical Department supplied data on deadly insect stings [14]. The Federal data on deadly insect stings were used to compare our results with the whole population of Switzerland. All statistical analyses were performed with Graphpad Prism. The t-test was used to compare weather data on days with recorded stings with the mean values over the whole sting period from June to September (rainfall, number of hours of sun relative to daylight hours, low humidity, high pressure and high temperature).

Results

Between 2009 and 2013, 143 patients were admitted to the ED as a result of a hymenoptera sting. In 2009, only 10 patients were admitted and in 2013 61 patients were admitted with hymenoptera stings (fig. 1). 86 (60.1%) patients were men and 57 (39.9%) women, with an average age of 43 years (range 19–84 years). The patients in the age category 21–30 years were stung the most often (fig. 2). In 126 (88.1%) cases, data were available on patient admission. Of these, 102 (71.3%) patients were self-admitted, 16 (12.5%) were brought by ambulance and 3 (2.5%) by helicopter.

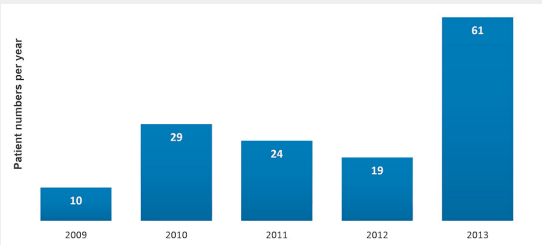

Figure 1

Health related data were analysed for patients admitted between 2009 and 2013 to the emergency department because of a hymenoptera sting. Here depicted are number of cases per year.

Local swellings were recorded in 96 (67.1%) of the patients at the site of the sting. About one third of the patients (49; 34%) exhibited an anaphylactic reaction (fig. 3). Of these, 31 (21.7%) were scored with a grade I reaction (19 men), 9 (6.3%) with a grade II reaction (5 men), 6 (4.2%) with a grade III reaction (6 men), and 3 (2.1%) with a grade IV reaction (3 men). One patient died because of cardiovascular collapse.

The most frequent clinical symptoms recorded in our patients are depicted in table 1. In two thirds (n = 96) of the cases, local swelling was recorded, in one third (n = 47) by a local erythema only. Loss of consciousness and hypotension were both recorded in 4 patients.

In 10% of the patients, medical therapy was not fully documented. Patients were most frequently given antihistamines (table 2): 66 (51.6%) patients were given intravenous clemastine and 58 (45.3%) oral levoceterizine. The second most frequent treatment was with glucocorticoids: 64 (50.0%) of the patients were given intravenous methylprednisolone, 20 (15.6%) prednisolone and 19 (14.8%) prednisone. Thus, 124 (96.9%) of the patients were given antihistamines and 103 (80.4%) glucocorticoids.

Only 16 patients (12.5%) were given epinephrine. In 9 (56.2%) patients, epinephrine was administered intramuscularly, in 7 (43.7%) patients by inhalation, in 3 (18.7%) intravenously, while 3 of these patients received both intra-

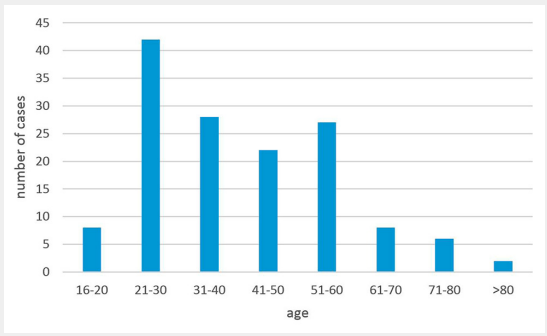

Figure 2

Age distribution of cases.

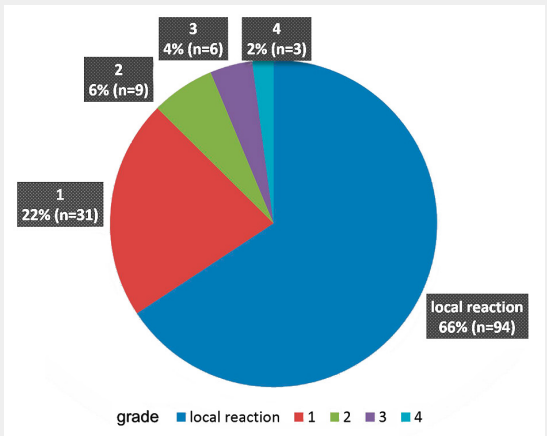

Figure 3

Anaphylactic reactions due to hymenoptera stings. Patients were scored according to Mueller et al [12] into local reactions, and grades I to IV (1–4) anaphylactic reactions.

muscular and inhalational administration. In patients with local swelling, epinephrine was applied prophylactically if they were stung in the buccal cavity. One patient exhibited a massive swelling of the tongue, such that in addition intubation was needed. However, in 4 patients, no epinephrine was given despite a grade III or IV anaphylactic reaction.

Most of the stings happened on weekends and Wednesdays. On Mondays fewest stings were recorded (fig. 4). August was the month with most stings, followed by July and September (fig. 5).

Most stings were recorded on days with: (a) less or no rainfall ($p = 0.007$) with a mean rainfall on days with stings of 1.9 mm compared with a mean rainfall in the time from June–September 2009–2013 of 3.2 mm; (b) more hours of sunshine in relation to the number of daylight hours ($p <0.001$) with 69.7% sunshine of the possible day-length on days with stings compared with the mean of 55.5% during June–September 2009–2013; (c) a lower mean humidity of 71.9% ($p = 0.003$) on days with stings in comparison with the mean humidity from June–September 2009–2013 of 74.0%; (d) higher pressure ($p = 0.004$) with a mean atmospheric pressure of 954.3 hPa on days with stings and a mean of 953.2 hPa between June–September 2009–2013; and (e) higher maximum day temperature ($p <0.001$) with a mean of 24.2 °C on days with stings compared with a mean of 22.8 °C June–September 2009–2013 (fig. 6).

The most frequent sting sites were the head (n = 33; 22.5%), hands (n = 32; 22%) and arms (n = 26; 18%) (fig. 7). In women, the most frequent site was the feet and hands, in men the legs and head. There were 17 (11.6%) enoral stings, mostly due to inattentive drinking.

Discussion

Hymenoptera stings are a significant problem in the ED [15]. On the one hand, people are afraid of potential systemic or severe reactions after stings, since an anaphylactic reaction cannot be foreseen, and on the other hand people in our society have little experience of managing simple and normal local sting reactions. Nevertheless, in the Canton of Bern, the annual incidence of anaphylactic reactions is 7.9–9.6 cases per 100 000 population. Of these, 58.8% are induced by hymenoptera stings [4]. This suggests that many cases of anaphylactic reaction are treated outside the university ED. The incidence of anaphylactic reactions – both in Bern and elsewhere – has increased steadily over time, apart from the strikingly high value in 2013 [15].

Our results could indicate that men more often suffer stings and more often exhibit a severe anaphylactic reaction than do women. However, this has not been found in other studies [16, 17]. Furthermore, the ratio of all patients, independent of the reason for admission, that were admitted to the ED in the last 10 years was around 40% female to 60% male. Therefore, we suppose that this is the normal gender ratio of the patients admitted to our ED. The number of pa-

Table 1: Observed clinical symptoms.

Symptom	Proportion of patients (%)	Number of patients
Swelling	67.1%	96
Erythema	32.9%	47
Pruritus	21.0%	30
Pain	16.8%	24
Urticaria	16.8%	24
Generalised pruritus	14.0%	20
Generalised erythema	13.3%	19
Facial swelling	7.7%	11
Hyperthermia	5.6%	8
Chest tightness	4.9%	7
Paraesthesia	4.9%	7
Dyspnoea	4.2%	6
Nausea	2.8%	4
Loss of consciousness	2.8%	4
Hypotension	2.8%	4

Table 2: Medication and interventions of patients.

Drug / intervention	Proportion of patients (%)	Number of patients
Clemastine i.v	51.6%	66
Methylprednisolone i.v.	50.0%	64
Levocetirizine dihydrochloride p.o.	45.3%	58
Prednisolone	15.6%	20
Prednisone	14.8%	19
Epinephrine	12.5%	16
Ranitidine	9.4%	12
Amoxicillin and clavulanic acid	7.0%	9
Amoxicillin	5.5%	7
Cooling	5.5%	7
NaCl	5.5%	7
Dimetindene maleate	3.9%	5
Ranitidine	3.9%	5
Cetirizine dihydrochloride	3.9%	5
Dimentindene maleate gel	2.3%	3
Elevation	2.3%	3
Ring removal	2.3%	3
Lorazepam	2.3%	3

i.v. = intravenous; p.o. = oral

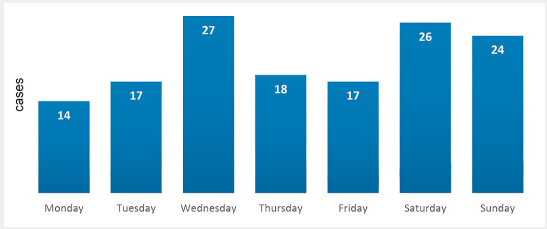

Figure 4

Distribution of cases per weekday. Case numbers are depicted according to the day of the week.

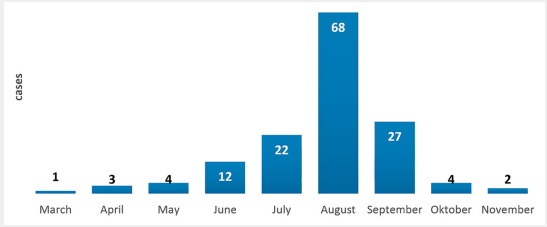

Figure 5

Distribution of cases by month. Case numbers are depicted by month.

tients in this study does not allow the significance of this assertion to be assessed, but could indicate a trend.

Stings can induce a local or systemic reaction. In the present study, 66% of the patients exhibited a local reaction. In central Europe, around 25% of the population exhibit major local reactions [18] and in a multicentre study in 15 North American EDs, 58% of the patients had a local reaction [19]. This number of finally local sting reactions suggest that in our ED more trivial cases are admitted compared with other EDs. In the study of the North American EDs 11% of the admitted patients with hymenoptera stings exhibited a grade I to III reaction and 41% a grade IV reaction [19]. This was in contrast to the findings in the present study, where 32% of the patients exhibited a grade I to III and only 2% a grade IV anaphylactic reaction. It remains unclear why the majority of patients who presented to our ED with a hymenopteran sting were suffering only local reactions and, equally, if this applies to the whole of Switzerland. It may be that the people living in Switzerland are more sensitive to the risk of stings, as on average

Figure 6

Meteorological data. Each dot represents a day without recorded hymenoptera sting (blue) or a day with a hymenoptera sting (orange). Maximal temperatures are shown in A, numbers of sunshine compared with daylight hours in B, air pressure data in C and precipitation in D.

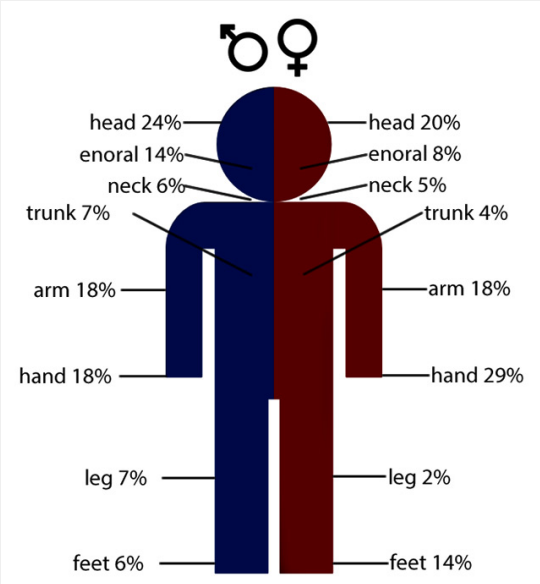

Figure 7

Localisation of recorded stings for each body region in men (blue) and women (red).

three persons die of stings each year, which gives a fatality rate of 0.43 per million population per year [14]. This is relatively high compared with the numbers in a review of the epidemiology of life-threatening and lethal anaphylaxis, which reported about 0.09–0.45 to 3 deaths by severe anaphylaxis induced by hymenoptera per 1 million people [3]. In a study from the USA the overwhelming majority of hospitalisations or ED presentations for anaphylaxis did not result in death, as an average case fatality rate of 0.3% was reported [20]. Some older studies form Sweden and Australia reported a case fatality rate of 0.2 per million and 0.086 per million population, respectively [21, 22]. Furthermore, in the canton of Bern the annual incidence of anaphylactic reactions due to hymenoptera stings has been calculated to be as high as 45 [4]. A second reason might be that the population is unaware that the risk of anaphylaxis is not increased if the local reaction is severe rather than mild [16]. Nevertheless, Moneret et al. reported in their review of the epidemiology of life-threatening and lethal anaphylaxis that there is definitive agreement on the figures for the incidence of severe anaphylaxis (1–3 cases per 10 000 inhabitants) [3] and that most cases of severe anaphylaxis were induced by hymenoptera stings [23].

The vast majority of patients admitted to our ED were treated with a combination of antihistamines and corticosteroids and only very few patients (12.5%) with epinephrine. Although in most guidelines of many medical societies epinephrine is emphasised as the drug of choice in anaphylaxis. However the use of epinephrine is in agreement with other reports, in which only a minority of patients are treated with epinephrine [18, 19, 23]. Epinephrine was rarely used, and in four patients no epinephrine was used even though it was indicated. This shows that physicians are reluctant to use this drug even in cases with circulatory and or respiratory problems, as reported by Trepp [24].

Stings were most often recorded on weekends and Wednesdays. This is not surprising, as on weekends in the summer people are often outside. In Switzerland on Wednesday afternoons most children are not at school so consequently more people may spend their time with their children outside and thus are at increased risk of a hymenoptera sting.

More wasps are in flight as the temperature increases [25, 26]. A study by the institute of neurobiology of the University Düsseldorf in the year 2002 showed a significant positive linear correlation between the daily temperature and the activity of bees. In the same study a negative linear correlation of humidity and the activity of bees was shown [27]. Thus our data that hymenoptera stings are more frequent on days and months with increased temperatures and less humidity corresponds to other studies [15]. Analysing the meteorological data [13] we could find a slightly higher mean value of the minimum temperature and a slightly lower relative humidity over the sting period of 4 months.

Most stings are in the area of the head and the neck (40%). These are often related to inattentive drinking and, in some cases, to wearing helmets while driving a motorcycle or bicycle. Stings of the upper and then the lower extremities are rarer, as published previously [15]. Extremities are more often exposed and women may tend to wear open

sandals, whereas men may more often wear closed shoes and this protects them from stings.

Limitations

This is a retrospective observational study with routinely recorded patient data of the ED. Therefore only patients with hymenoptera stings recorded by the treating physician were included.

Conclusion

In this study, most hymenoptera stings induced only local swelling and severe reactions were rare.

Half of the stings were in the head and neck region; the most dangerous were enoral stings that were mostly due to inattentive drinking.

Most stings are to be expected on long, dry and warm days with high air pressure.

Epinephrine is rarely used in anaphylactic reactions.

Disclosure statement: No financial support and no other potential conflict of interest relevant to this article was reported.

Correspondence: *Christian Braun, MD, University Emergency Department, Insel Hospital, University Hospital Bern, Freiburgstrasse, CH-3010 Bern, christian.braun[at]insel.ch*

References

1 NZZ. Neue Zürcher Zeitung, 23 October 2013. Available from: http://www.nzz.ch/wissen/wissenschaft/zusammenspiel-von-faktoren-fuer-verluste-verantwortlich-1.18171819

2 Asai Y, Yanishevsky Y, Clarke A, La Vieille S, Delaney JS, Alizadehfar R, et al. Rate, triggers, severity and management of anaphylaxis in adults treated in a Canadian emergency department. Int Arch Allergy Immunol. 2014;164(3):246–52.

3 Moneret-Vautrin DA, Morisset M, Flabbee J, Beaudouin E, Kanny G. Epidemiology of life-threatening and lethal anaphylaxis: a review. Allergy. 2005;60(4):443–51.

4 Helbling A, , Hurni T, Mueller UR, Pichler WJ. Incidence of anaphylaxis with circulatory symptoms: a study over a 3-year period comprising 940,000 inhabitants of the Swiss Canton Bern. Clin Exp Allergy. 2004;34(2):285–90.

5 Worm M, Eckermann O, Dölle S, Aberer W, Beyer K, Hawranek T, et al. Triggers and treatment of anaphylaxis: an analysis of 4,000 cases from Germany, Austria and Switzerland. Dtsch Arztebl Int. 2014;111(21):367–75.

6 A. Helbling, T.H., Mueller UR, Pichler WJ. Incidence of anaphylaxis with circulatory symptoms: a study over a 3-year period comprising 940000 inhabitants of the Swiss Canton Bern. Clin Exp Allergy. 2004;34:285–90.

7 Hompes MWS. Das deutschsprachige Anaphylaxie-Register, in Bundesgesundheitsbl. 2012;55:380–4.

8 Ewan PW. Venom allergy. BMJ. 1998;316(7141):1365–8.

9 Fitzgerald KT, Flood AA. Hymenoptera stings. Clin Tech Small Anim Pract. 2006;21(4):194–204.

10 Helbling A, Fricker M, Bircher A, Eigenmann P, Eng P, Köhli-Wiesner A, et al. Notfallbehandlung beim allergischen Schock. Schweiz Med Forum. 2011;11(12):206–12.

11 Werdan U.M.-W.u.K. Anaphylaktischer Schock. In: Intensivmedizin. 2004: ecomed-Verlag; Eckart, Forst, Burchardi (Herausgeber); 2004, ISBN 3-609-20177-0.

12 Mueller H, Hill L. Allergic reactions to bee and wasp stings. N Engl J Med. 1953;249(18):726–31.

13 MeteoSchweiz, B.f.M.u.K., https://shop.meteoswiss.ch/productView.html?type=psc&id=17. 2009 bis 2013.

14 E.K., W., Deaths due to hymenoptera stings in Switzerland. 2015, Informationservice of health, EDI, federal statistical department.

15 Caffier PP, Schrom T, Haupt H, Mazurek B. Increasing incidence of wasp stings in otorhinolaryngological practice. HNO. 2006;54(6):451–6. German.

16 U.R., M. Insektenstichallergie. Klinik, Diagnostik und Therapie. 1988, Stuttgart: Gistav Fischer Verlag.

17 Chen W, Mempel M, Schober W, Behrendt H, Ring J. Gender difference, sex hormones, and immediate type hypersensitivity reactions. Allergy. 2008;63(11):1418–27.

18 Przybilla B, Rueff F. Insect stings: clinical features and management. Dtsch Arztebl Int. 2012;109(13):238–48.

19 Clark S, Long AA, Gaeta TJ, Camargo CA Jr.. Multicenter study of emergency department visits for insect sting allergies. J Allergy Clin Immunol. 2005;116(3):643–9.

20 Ma L, Danoff TM, Borish L. Case fatality and population mortality associated with anaphylaxis in the United States. J Allergy Clin Immunol. 2014;133(4):1075–83.

21 Johansson B, Eriksson A, Ornehult L. Human fatalities caused by wasp and bee stings in Sweden. Int J Legal Med. 1991;104(2):99–103.

22 Harvey P, Sperber S, Kette F, Heddle RJ, Roberts-Thomson PJ. Bee-sting mortality in Australia. Med J Aust. 1984;140(4):209–11.

23 Valent P. Risk factors and management of severe life-threatening anaphylaxis in patients with clonal mast cell disorders. Clin Exp Allergy. 2014;44(7):914–20.

24 Trepp. Emergency treatment of patients with hymenoptera venom allergy. Is the treatment in accordance with the guidelines? Respiration. 2013;85(6).

25 Dettner K, Peters W. Lehrbuch der Entomologie. 2. Aufl. Spektrum Akademischer Verlag, Heidelberg, 2003.

26 Witt R. Wespen beobachten, bestimmen. Naturbuch-Verlag, Augsburg, 1998.

27 Walge C, Lunau K. The fauna of wild bees (Hymenoptera, Apoidea) at the campus of the Heinrich-Heine-University of Düsseldorf. Acta biologica benrodis. 2002;11:27–44.

Figures (large format)

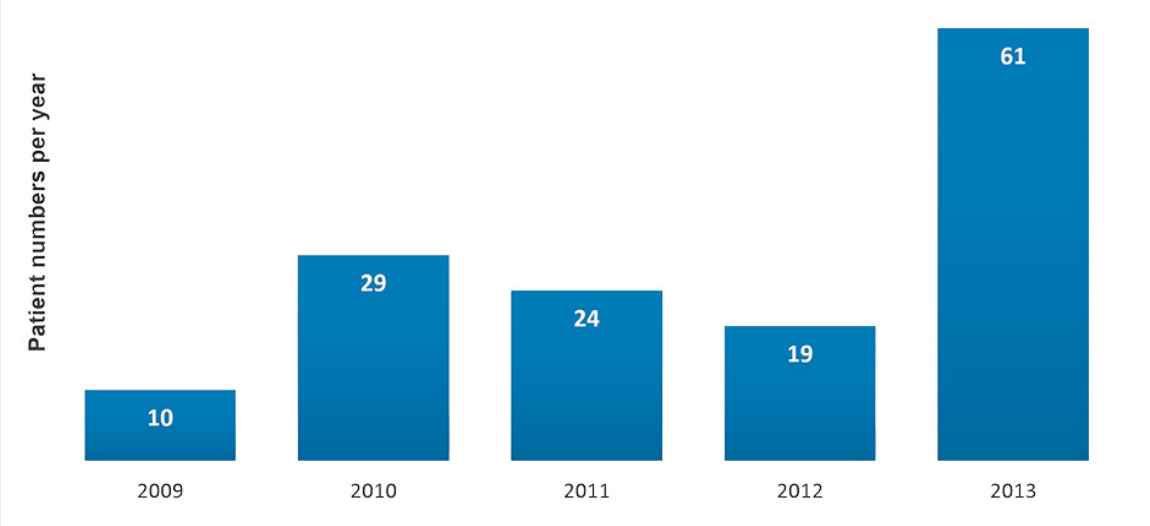

Figure 1

Health related data were analysed for patients admitted between 2009 and 2013 to the emergency department because of a hymenoptera sting. Here depicted are number of cases per year.

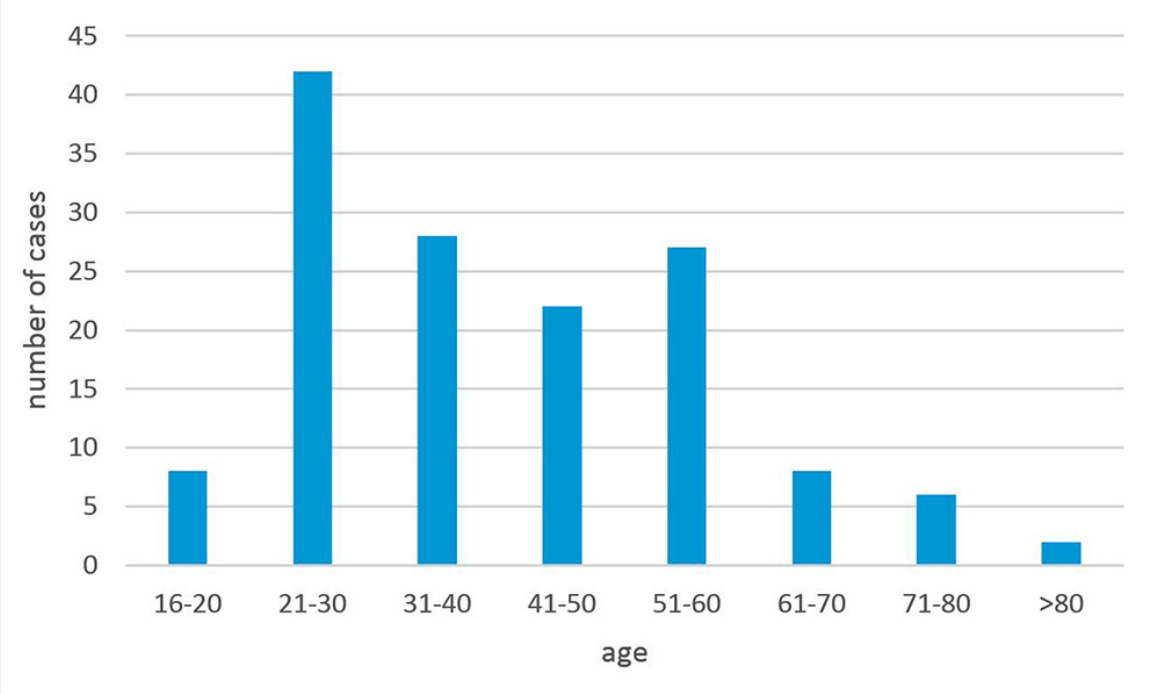

Figure 2

Age distribution of cases.

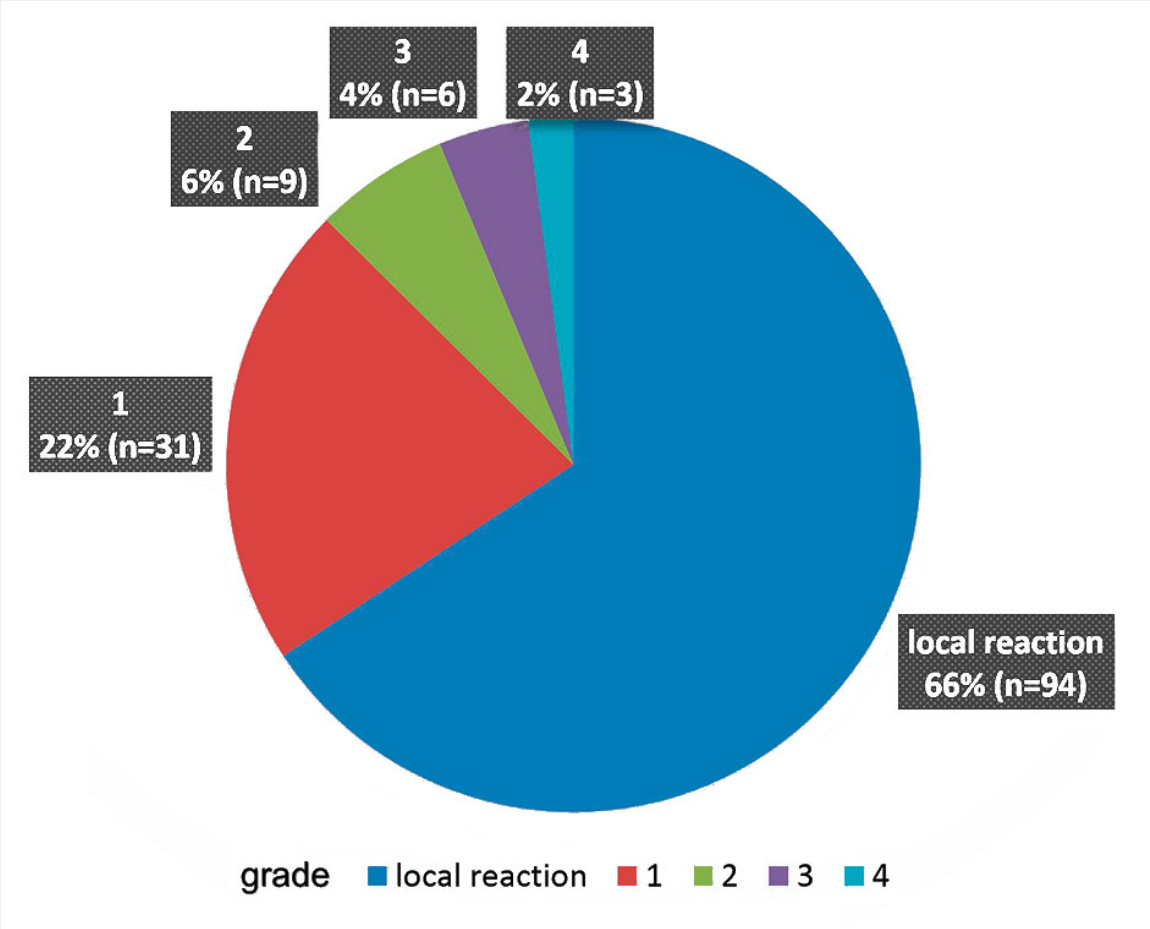

Figure 3

Anaphylactic reactions due to hymenoptera stings. Patients were scored according to Mueller et al [12] into local reactions, and grades I to IV (1–4) anaphylactic reactions.

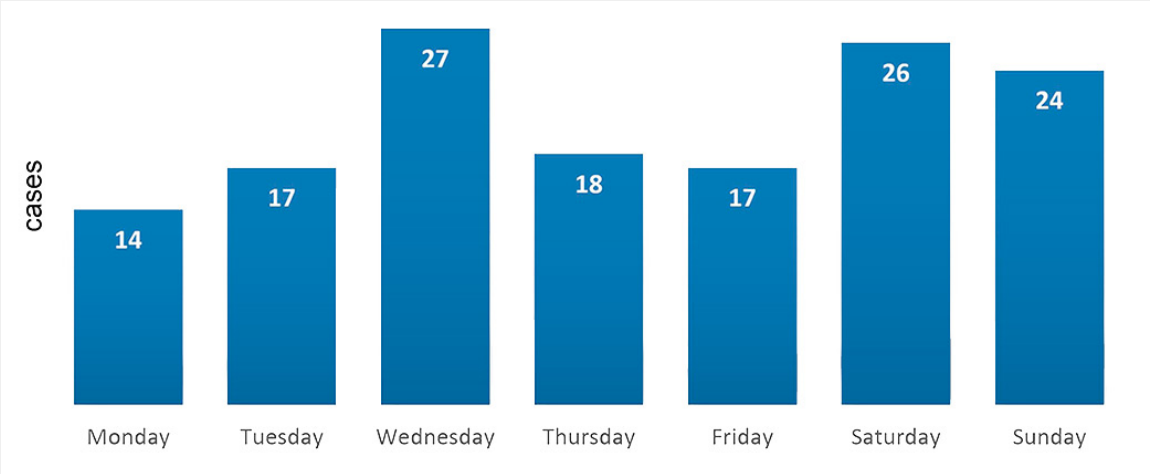

Figure 4

Distribution of cases per weekday. Case numbers are depicted according to the day of the week.

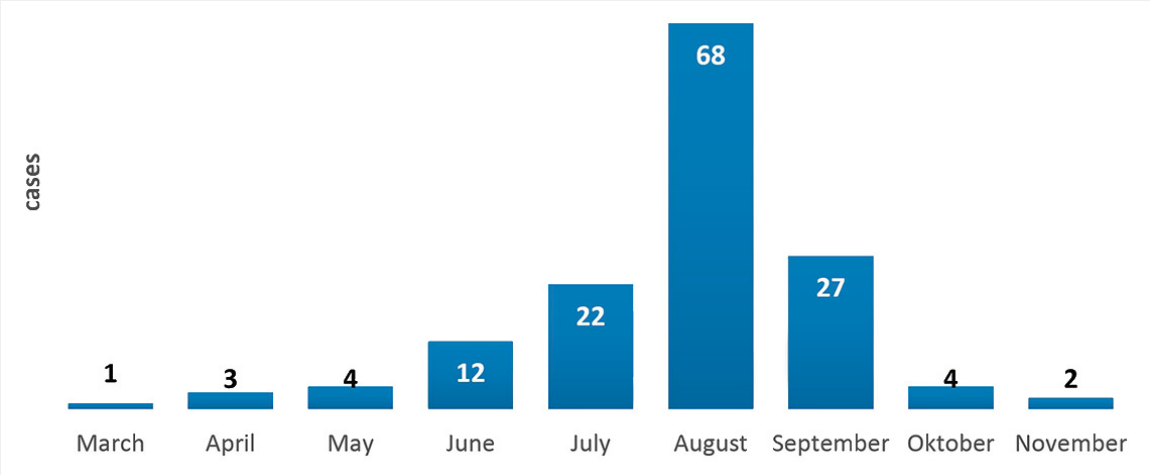

Figure 5

Distribution of cases by month. Case numbers are depicted by month.

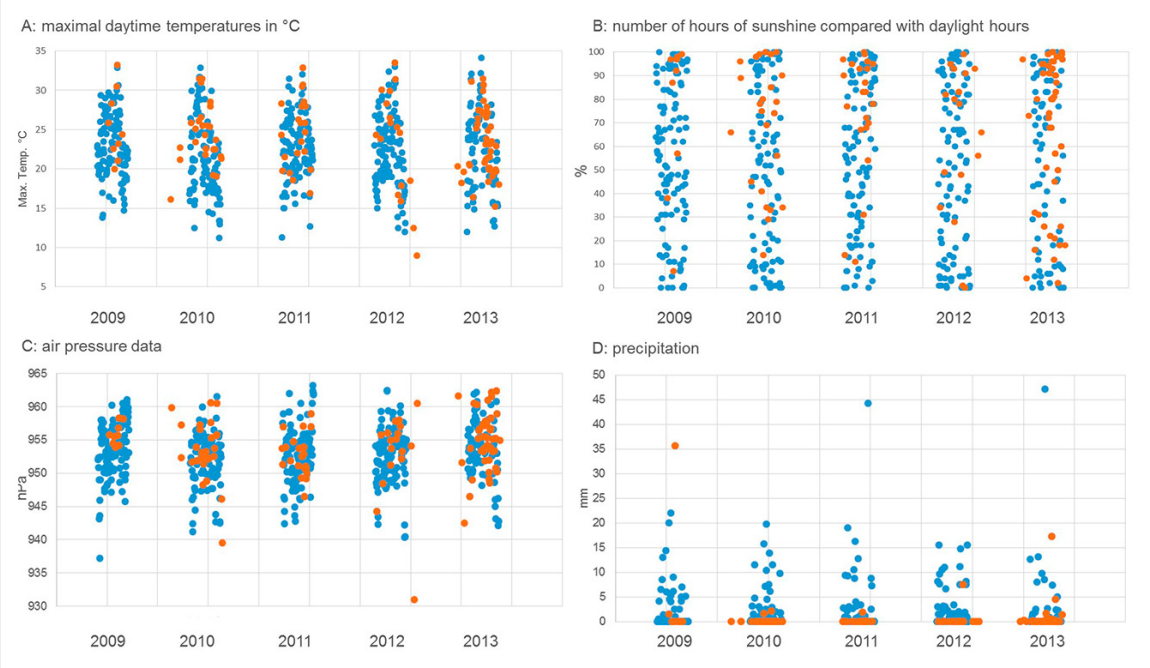

Figure 6

Meteorological data. Each dot represents a day without recorded hymenoptera sting (blue) or a day with a hymenoptera sting (orange). Maximal temperatures are shown in A, numbers of sunshine compared with daylight hours in B, air pressure data in C and precipitation in D.

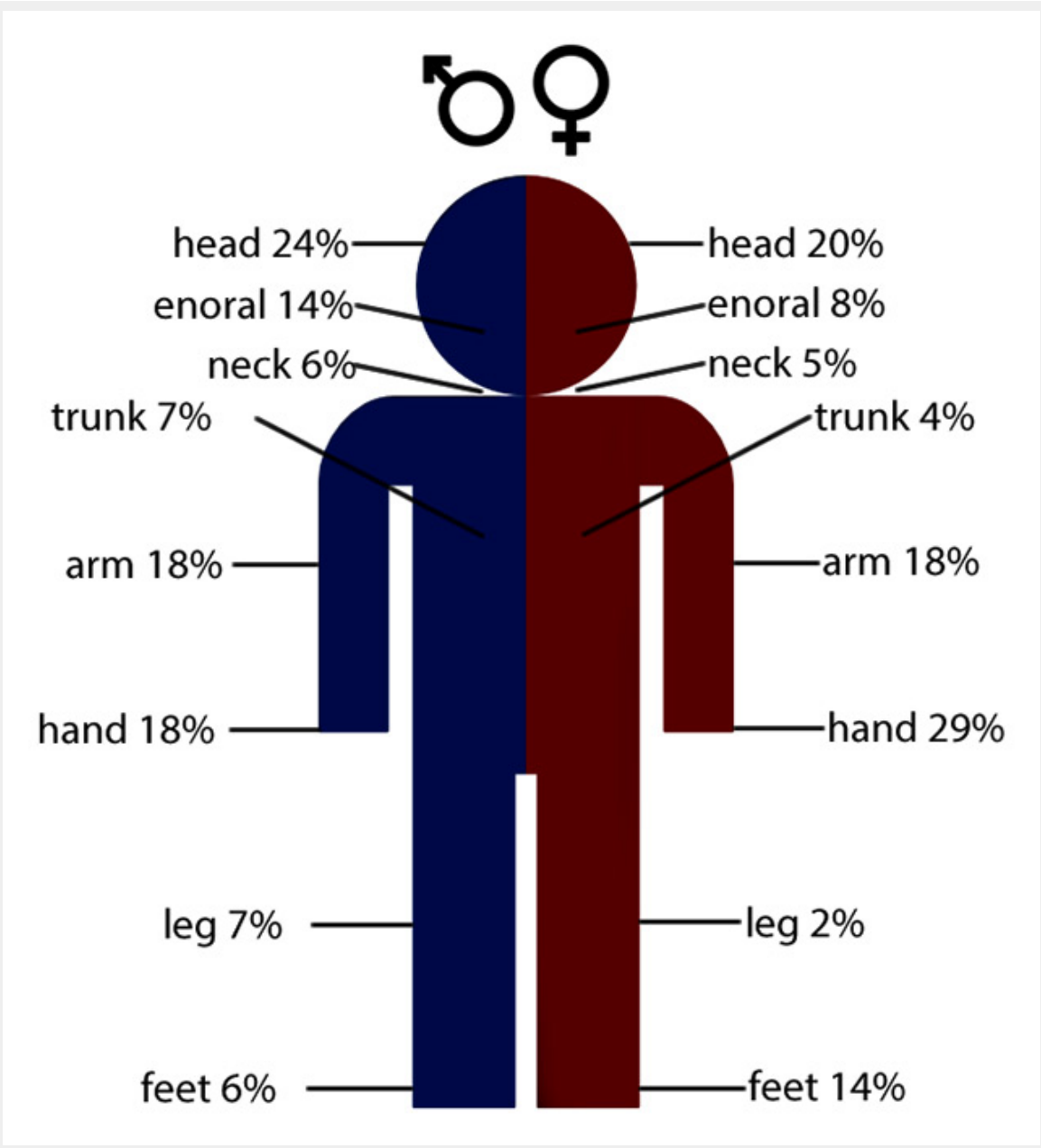

Figure 7

Localisation of recorded stings for each body region in men (blue) and women (red).